

## Chapter 5

# Remediation Considerations

The NSI data evaluation is designed to provide screening level assessments of sediment quality based on the probability of adverse effects on aquatic life and human health. This report is not designed to be used to make potential risk-management or remediation decisions, but to identify areas where information exists that suggests that contaminated sediments may be causing adverse effects. In order to determine if remediation is warranted, more site-specific detailed information than this report contains would need to be collected and analyzed in targeted areas. Therefore, recommendations regarding risk management and remediation options based on the data utilized in this report are not made. This being said, the current sediment quality results indicate that 39 percent of the sampling stations are classified as Tier 1 and that 88 watersheds contain areas of probable concern or APCs (see Chapter 3 - Findings for further details regarding these classifications). Sediment remediation could be considered in some of these areas as well as others if further evaluation indicates an unacceptable risk. To assist in any future sediment remediation it is prudent to begin compiling information concerning all remediation alternatives and the various factors affecting remediation decisions (e.g., associated costs, and biological results from post-remediation monitoring). Where remediation is necessary, future remediation efforts may be undertaken by States, Tribes, and responsible parties, as well as partnerships of multiple parties, EPA and other Federal agencies. EPA expects to be involved as the lead party in only a small subset of sites. There are a variety of authorities to direct the remediation of contaminated sediments (e.g., CERCLA, RCRA, CWA, the Rivers and Harbors Act, and the Oil Pollution Act of 1990). However, most remediation of contaminated sediment at sites has been completed under CERCLA. The remainder of this chapter will focus on information developed under the Superfund program.

Since the initial *National Sediment Quality Survey*, the National Research Council has issued two reports on contaminated sediments: *Contaminated Sediments in Ports and Waterways: Cleanup Strategies and Technologies* (NRC, 1997) and *A Risk-Management Strategy for PCB-Contaminated Sediments* (NRC, 2001). Both reports offer useful technical information as well as a risk-management framework to guide decision-making at contaminated sediment sites. EPA has also issued several guidance documents on contaminated sediments which are consistent with the NRC reports: *EPA's Contaminated Sediment Management Strategy* (USEPA, 1998) and *Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites* (USEPA, 2001a [in preparation]). In addition, EPA is preparing a more detailed technical guidance *Contaminated Sediment Remediation Guidance*, which the agency expects to issue in draft form for public review in summer 2002 and in final form by fall 2002.

As described in the documents listed above, there are only a few options that have been consistently and effectively used for managing contaminated sediments. In addition to controlling the sources of the sediment contamination, remediation alternatives that have been used historically for the sediment itself include (1) dredging (under wet or dry conditions) with treatment or disposal, (2) in-situ capping, and (3) monitored natural recovery. Each of these options are described very briefly below. These options are not mutually exclusive; at many sites, a combination of options has proven to be the best solution. Institutional controls, such as fish consumption advisories, commercial fishing bans, or waterway use restrictions are frequently used to control risks to human health during a cleanup or occasionally as a stand-alone option. Additional innovative technologies including in-situ treatment and innovative reuses for dredged material are being studied at a number of sites by EPA and other parties and may offer additional future solutions for sediments.

As is recognized by both the NRC and EPA, identifying and controlling the sources of the sediment contamination is essential to any sediment cleanup. These sources might include, among others, direct discharges from industries or sewage treatment plants, runoff or erosion of contaminated soil from stream

banks or adjacent land, contaminated groundwater and non-aqueous phase liquid contributions, storm water discharges and combined sewer outfalls, upstream contributions, and air deposition. The three major sediment cleanup options in addition to source control are described below.

Dredging includes a variety of sediment removal techniques which can occur under water (“wet dredging”) or after water has been diverted from the waterway (“dry dredging”). Wet dredging is more often used for larger bodies of water; dry dredging is more often used for smaller bodies of water and for wetlands. After removal, the contaminated sediment almost always requires dewatering and could require treatment prior to disposal. Water from dewatering the sediment may also require treatment prior to discharge. Common disposal options include disposal in an upland landfill, disposal in a nearshore confined disposal facility (CDF), or disposal under water in a confined aquatic disposal (CAD) unit.

In-situ capping isolates the contaminated sediment by covering it with a cap. The cap can be constructed of granular material, such as clean sediment, sand, or gravel, or can involve a more complex design with geotextiles, liners, and multiple layers. Caps over contaminated sediment serve to physically isolate the sediment, to stabilize it so that it cannot be resuspended, and to reduce the movement of contaminants upward into near-surface sediment and the overlying water column.

Natural recovery (or when used as a remedy by EPA, “monitored natural recovery”) is a clean-up option in which ongoing naturally occurring processes are relied-upon to bury, transform, or biodegrade the contaminants. A variety of physical, biological, and chemical processes may act to reduce the risk and potential risk from the sediment. The most common natural process relied upon is burial by cleaner sediments through natural sedimentation. Evaluating the effects of natural processes on contaminated sediment is an essential part of any decision to remediate sediments.

In its 2001 report, the NRC recommended the use of a risk-based framework for managing risks associated with sediments. Their framework was based on a framework developed by the Presidential/Congressional Commission on Risk Assessment and Risk Management. EPA decision-making processes are generally consistent with the NRC’s framework. The *Principles* Directive cited above (EPA, 2001a [in preparation]) recommends that site managers for CERCLA and RCRA sites make site decisions in a risk-based framework employing an iterative decision and cleanup process as appropriate; evaluate the short-term and long-term risks of all potential cleanup alternatives; and, consider the societal and cultural impacts of sediment contamination and potential remedies through meaningful involvement of the affected community. The Directive also recommends that all types of remedies (e.g., wet or dry dredging, in-situ capping, or monitored natural recovery) which can meet remedial action objectives should be evaluated in the selection of the remedy. At many sites, EPA has found that a combination of options will be the most effective way to manage the contamination.

As stated earlier, the largest number of sediment remediation projects undertaken by EPA occur in the Superfund program. For Superfund sites, each site is evaluated using site-specific data in order to determine the most appropriate remedy considering the National Contingency Plan’s (NCP’s) nine remedy selection criteria (40 CFR Part 300.430). The nine criteria are:

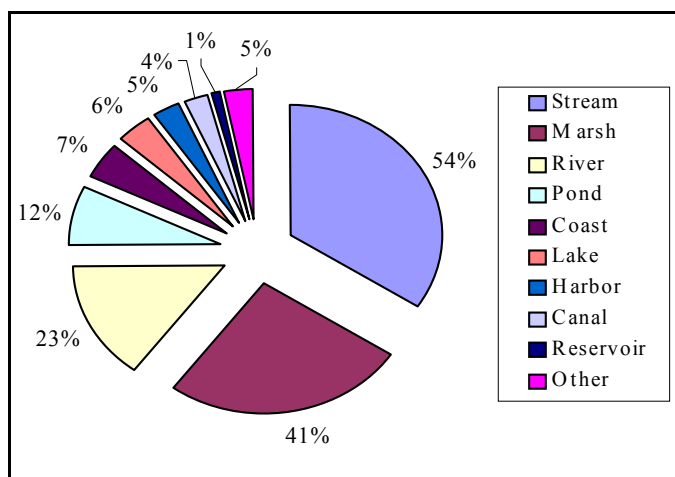
- Overall protection of human health and the environment;
- Compliance with applicable or relevant and appropriate requirements;
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, and volume through treatment;
- Short-term effectiveness;
- Implementability;
- Cost;
- State (or support agency) acceptance, and;

- Community acceptance.

The following text provides an overview of the types of waterbodies, contaminants, and remedies involved at Superfund sites with contaminated sediments. The information was gathered from the 10 EPA regions during the spring and summer of 2001 and represents approximately 140 sites where the EPA has decided to take an action for contaminated sediments under the Superfund program since approximately 1980. The following represents information currently available to the Agency. The information on most of the figures is presented as “percent of sites” rather than site numbers because site numbers vary from figure to figure; not all the information was available for all 140 sites. The figures include information on both removal actions (emergency, time-critical and non-time-critical actions) and remedial actions. The majority of these actions, but not all the actions, are the final sediment action for the site. Some of the actions have been completed; others are in process or have not yet been implemented.

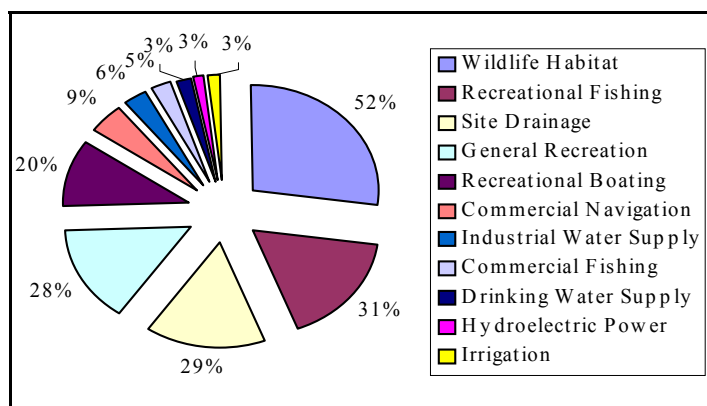
### *Types of Waterbodies*

Figure 5-1 presents the types of waterbodies which have been addressed at Superfund sediment sites. Note that many sites include contaminated sediments in more than one type of waterbody, so the percentages do not total 100%. For example, this figure shows that slightly more than 50% of sites where the Superfund program has made a cleanup decision address sediment in streams. At some of these sites, Superfund has also addressed sediment in another type of waterbody and the same site is therefore included in the percentages shown for that waterbody type as well. Sediment decisions at about 40% of sites address sediments in marshes. Sediment decisions at 20 to 25% of sites address sediment in rivers. Cleanups at smaller percentages of sites address other types of waterbodies, such as ponds, coastal areas, lakes, harbors, canals, reservoirs, or others. Note that these percentages are not a representation of areal extent or volumes of contaminated sediments.



**Figure 5-1. Types of Waterbodies addressed at Superfund Sites**

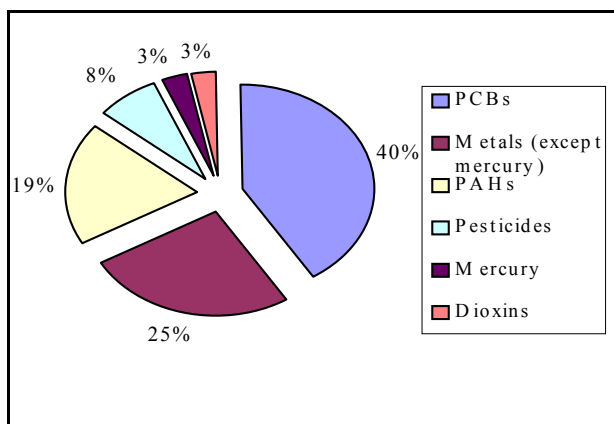
Figure 5-2 presents the wide range of current uses (in many cases, impaired uses) of waterbodies where Superfund has made a sediment cleanup decision. These uses include wildlife habitat, recreational and subsistence fishing, site drainage, general recreation, recreational boating, commercial navigation, industrial water supply, commercial fishing, drinking water supply, hydroelectric power, and irrigation. Note that many sites have more than one type of use, so the percentages do not total 100%.



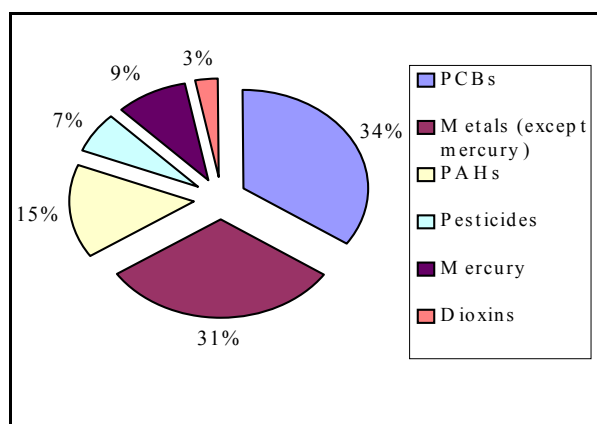
**Figure 5-2. Relative Frequency of Uses of Waterbodies addressed at Superfund Sites**

## Contaminants

Figures 5-3a and 5-3b present the major contaminants (or groups of contaminants) which Superfund sediment cleanup decisions have cited as contributing the greatest human health and ecological risk. PCBs are the most commonly cited contaminant contributing the greatest risk at sites where EPA has made a sediment cleanup decision, followed by metals, PAHs, pesticides, and other contaminants. Many sites had multiple contaminants contributing to human health and ecological risk, but at most sites, one contaminant was determined to be contributing the greatest risk. However, this is not the case at every site, so the percentages do not total 100%.



**Figure 5-3a. Contaminants Superfund Sediment Cleanup Decisions cited as contributing the Greatest Human Health Risk**

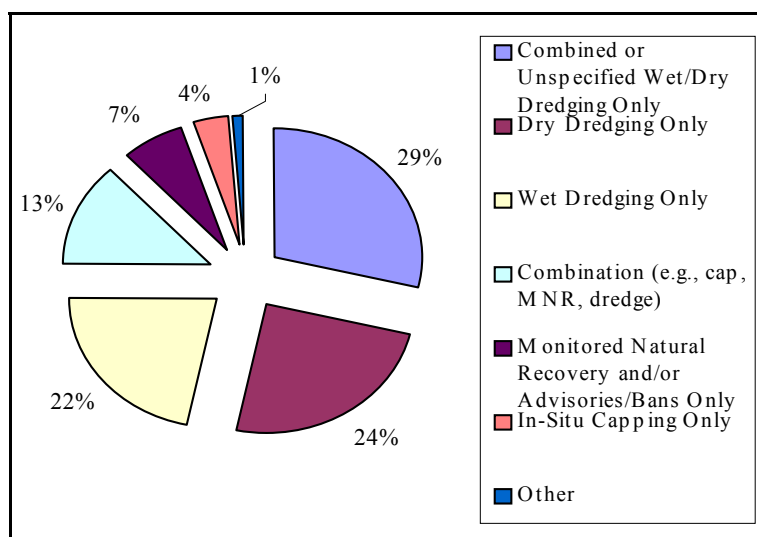


**Figure 5-3b. Contaminants Superfund Sediment Cleanup Decisions cited as contributing the Greatest Ecological Risk**

## Cleanup Methods

Figure 5-4 presents the types of cleanup methods selected at Superfund sediment sites. This figure shows that about 75% of Superfund decisions for sediments specify dredging as the remedy. (Note that this figure includes sites where fish consumption advisories or commercial fishing bans were also part of the remedy.) Where the dredging method (i.e., wet vs. dry) is known, about half of the dredging sites are using “dry dredging” (i.e., where the dredging is conducted after diversion or removal of water). Note that past sediment remedies have not generally cited the use of monitored natural processes when cleanup levels were expected to be reached using dredging alone, even when natural processes were expected to lead to even lower surficial contaminant levels over time.

About 10 to 15% of Superfund sediment remedies involve a combination of major cleanup methods at the site, i.e. at least two of



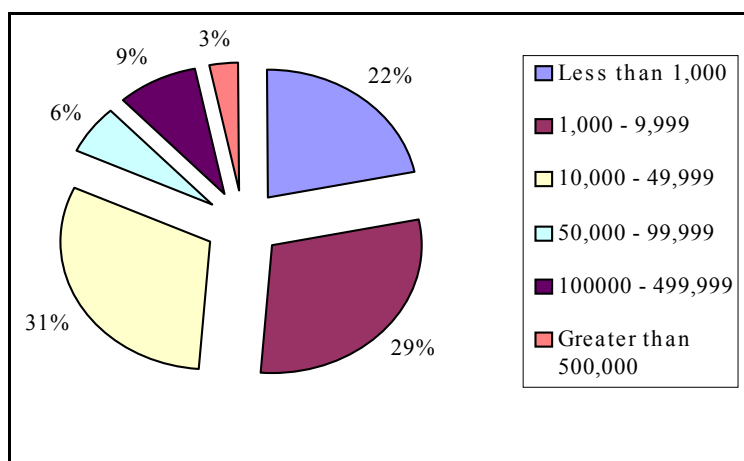
**Figure 5-4. Types of Cleanup methods selected at Superfund Sediment Sites.**

the three major cleanup methods of in-situ capping, monitored natural processes, and dredging. Frequently monitored natural processes or in-situ capping are combined with dredging of the most highly contaminated sediments or hot spots. About 7% of Superfund sediment cleanups use monitored natural processes (“MNR”, such as natural burial with clean sediments) and/or fish consumption advisories alone; and about 10% of sites include MNR as at least part of the remedy. About 4% of sites include in-situ capping as the sole sediment remedy, and about 15% of sites in-situ capping as part of the remedy.

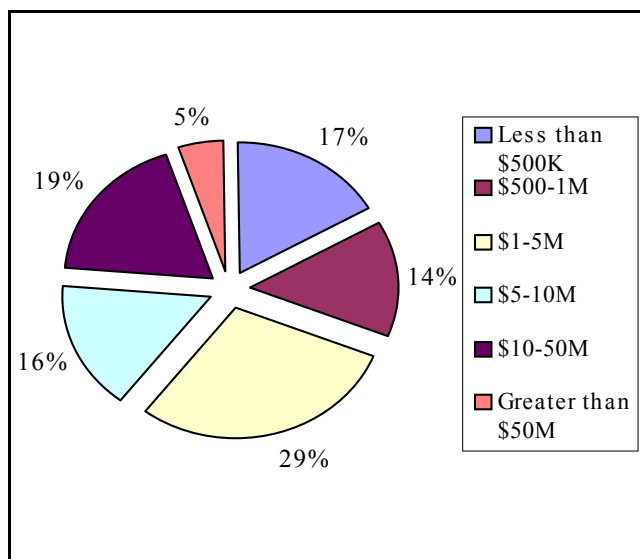
Figure 5-5 presents the range of sediment volumes dredged per Superfund dredging site, for the sites for which these volumes were available and differentiated from upland and floodplain soil volumes. The dredging volumes presented here include both “wet” and “dry” dredging. At about 22% the sites, dredging involved less than 1,000 cubic yards of sediment. At about 50% of the sites, dredging involved less than 10,000 cubic yards of sediment. At about 80% of the sites, dredging involved less than 50,000 cubic yards of sediment. The remaining 20% of Superfund sediment dredging sites were relatively large, with a few exceeding 1 million cubic yards.

#### Cost

Figure 5-6 presents the range of costs associated with Superfund sediment cleanups of more than 1,000 cubic yards, for those sites where estimated or actual sediment cleanup costs were available and differentiated from those associated with other media, such as soils or groundwater. For completed cleanups, actual costs were used; for cleanups in the planning stages, estimated costs were used. About 30% of sites, total sediment cleanup costs were less than \$1 million (If sites smaller than 1,000 cubic yards were included, this percentage would be larger). An additional 30% of sites, sediment costs were between \$1 million and \$5 million. Costs at larger sites range upward to include about 5% of sites for which sediment costs exceed \$50 million.



**Figure 5-5. Range of Sediment Volumes (measured in cubic yards) dredged per Superfund dredging site**



**Figure 5-6. Range of Costs associated with Superfund Sediment Cleanups**